YOKOI'S THEORY OF LATERAL INNOVATION: APPLICATIONS FOR LEARNING GAME DESIGN

By

SCOTT J. WARREN* GREG JONES**

* Assistont Professor, Deportment of Leorning Technologies, University of North Texos, Denton, TX .
**Assistont Professor, Deportment of Leorning Technologies, University of North Texos, Denton, TX .

ABSTRACT

There are several major challenges for instructional designers seeking to design learning games. These include the lack of access, the cost of rapidly advancing/expensive technology tools that make developing games uneconomical, the institutianal time canstraints limiting game use, and the cancerns that schaals lack sufficiently rabust computer systems and bandwidth ta allow their teachers and students to take full advantage of "bleeding edge" technalogy. This paper discusses how a theory of design from famed game system designer Gunpei Yokoi can be leveraged in learning game design by focusing on the use of mature technologies already widely present in schools. By thinking about older technalagies in innavative ways instead af relying on the flash af the newest graphics ta mativate learners, learning game design can deliver low-cost, engaging play for learning.

Keywards: Yakoi, Lateral Thinking, Game Design, Learning, Instructianal Design, Mature Technalagies.

INTRODUCTION

The use af digital games, simulatians, and ather camplex systems ta support learning in educatianal environments are at the forefront of the current push in the field of education, with the call coming from mony quarters to seek aut the mativating aspects af such canstructs as a means of improving learning (Prensky, 2001; Squire, 2006). Research on these systems has been correlated to imprave student mativatian ta learn (Tuzun, 2004), imprave understanding af histarical cancepts (Squire, 2004), improvement in student writing (Warren, Barab, & Dondlinger, 2008), and understanding of complex science cancepts and systems as well as sacial empathy and history content (Barab et al., 2007; Dede, Ketelhut, & Ruess, 2006). While these are promising results that bear further study, the projects that suppart the game warlds are often funded with millions of dallars in gavernment funding, which mokes employing the technologies ond accompanying designs difficult far the average practitianer. The high-end graphics, lang develapment times, and large staffs enjoyed by such projects allow for the development of game systems thot are closer to whot game campanies are develaping far cammercial entertainment uses. Since these resaurses are nat narmally available ta educators interested in designing and building learning games, we must exomine what is ideal and what is actually possible when creoting learning games.

Costs of the Bleeding Edge

So-called "bleeding edge" technalagies may be defined as (i) sa new that the user is required ta risk stability and productivity to use it (ii) the tendency of the technology to be extremely expensive (iii) there is o lack of consensus abaut the best appraach ta design and (iv) there is a lack of knowledge about the technology in the particular field in which it is being used (Wikipedia, 2008o). In recent years, the term has alsa been used ta refer ta technalagy that is "ahead af cutting edge," but still within the reach af those technically sophisticated to attempt its use. Users of such technology should expect that it should not olways wark as expected. The first definitian has been emplayed for this article.

What is prablematic from this perspective is that there is a lot of knowledge in the field of game design about the best woy to design for entertoinment, but much of this is kept cammercially secret in arder ta pratect trade

secrets. While there have been many books and articles published on the subject of designing games in general, there are far fewer published about how to design games for learning. In the field of education, our knowledge of how to design educational games that allow us to reach learning goals is still nascent, with only a few researchers reporting empirical studies that have found significant differences for learning (Dondlinger, 2007; Hays, 2005).

Over the last decade, a lot of money has been spent developing bleeding edge games, simulations, and other innovative systems that have life-like graphics, sounds, and experiences for those that can afford the systems. The cost of developing digital games has soared from reports of \$3 to \$6 million a few years ago to \$10 to \$20 million and more to make today (Takatsuki, 2007). When the Sony PlayStation 3 was in development, it was estimated that the cost of a single console would run \$494, but only sold for \$399 with the maker seeking to make a profit from their licenses to develop games for the system (Gamespot Staff, 2005).

The existence of such bleeding edge systems for commercial entertainment that many students and teachers already have at home creates a difficult tension for instructional designers and researchers seeking to exploit the motivating power of the game constructs that have been developed for these systems. If the learning affordances of these systems stem only from the ever-evolving graphics, sound, and interactions available from these systems, how can a designer of educational games match the explosive developments coming from the game industry? Should designers even try to keep up with the massive corporate games or return to more traditional curricula? Will students reject educational games that lack the high-powered graphics and interactions that are present in commercial games? These questions pose a fairly serious challenge for educators seeking to use them in classrooms and for designers considering their use as a basis for instructional systems development.

Another challenge that comes from attempting to leverage these new systems is that many instructional designers are researchers without advanced technical or programming skills. Their role as a designer is on guiding a process for system design, not on the physical creation of it. As a result, they must often turn to professionals with these skills, since most complex design projects are difficult to develop by a single professional. Even a small project requires several experts to provide the necessary technical skills to create something. Salaries for these experts range from \$55,000 US a year to a high of around \$85,000 US for an experienced game programmer (International Game Developers Association, 2008).

This expense may in turn require the constant seeking of grants from governmental and private sources, which further reduces the time that the instructional designer has to supervise the game's design. It therefore makes more sense to focus less on "bleeding edge technologies for improving learning" and more on "bleeding edge innovations that leverage technology for improving learning" using existing or re-examined technologies. Another possibility is to examine our thinking about how we leverage technology to design games for learning. Yokoi's theory has been used for several decades and can provide some ideas for teachers and instructional designers with small or no budgets and limited technology proficiency.

Yokoi's Theory: Lateral Thinking about Withered Technology

Gunpei Yokoi was a long-time designer of game system components for the Nintendo Company of Japan, currently well-known for its *Wii* game console as well as popular video game characters like Mario and Donkey Kong (Crigger, 2007; Wikipedia, 2008b). His most notable achievement was designing Nintendo's highly successful *Game Boy* system. This evolved from his personal philosophy of design, which he called "Lateral Thinking of Withered Technology". This was originally depicted in a book of interviews with the famed Nintendo game system designer called "Yokoi Gunpei Game House". Lateral thinking has been conceived in the research literature as non-linear, creative or critical thinking that allows for multiple, often innovative solutions to problems (Barak & Doppelt, 1999; DeBono, 1968; Waks, 1997). The term "withered" simply refers to technologies that have matured to the point that they are inexpensive,

understood by the general public, and require little training on the port of the user to be implemented easily (Wikipedia, 2008b). By opplying linear thinking to such mature technologies, his theory stated thot they could be employed in innovative ways that would engage users without adding unnecessary cost to the products.

What matters in the context of this theory is thot the novelty of the play and the interactions between ployer and system are intrinsic motivation rather than having top-end graphics and high-end computer processor power (Crigger, 2007). By employing this philosophy, it wos reveoled that it is more cost effective to rely on older, proven technologies for design rather than bleeding edge technologies and he even went so far os to suggest thot employing odvonced technologies may interfere with designing innovotive products because of excess focus on the technology rather than on the innovate use of it. Further, the design and development time is lower when applying laterol thinking obout mature technologies than it is for "bleeding edge" products, because they are proven to work effectively even as they sove both the developer and user money. In many educational settings shrinking budgets and reduced grant funding are recurrent problems. How then can be Yokoi's theory leveraged in the field of education as we seek to design games for leorning?

Re-examination

The bosic principle of loterol thinking is to generate new ideos and opproaches, without regard to order or sequence (Barak & Doppelt, 1999; DeBono, 1968; Waks, 1997). This forces the examination of technologies that ore already obundont in specific educotion settings in creative ways that force instructional designers to think differently obout how things must be done. Instead, designers must think obout alternatives to the existing ways of using a well-known technology thot are more engaging for the learners by challenging them to act in novel ways in response to our instructional designs. For example, the outhors have reod numerous books obout game design ranging from Salen and Zimmerman's *Rules of Play (2004)* to Crawford's *Art of Interactive Design (2003)* that hove each provided concrete ideas obout what a game must include and processes by which games should be designed. By synthesizing rules thot are offered by both of these authors, we may be led to stote that a game must include a) a rule-bosed interactive system, b) a quantifiable outcome characteristic, c) artificiol conflict ond play characteristics, ond may also include d) a modeling reality characteristic (Dondlinger & Warren, in press).

What is problematic is that if o designer takes these as hard and fast rules instead of employing lateral thinking, they moy be constricted by thinking thot each element must be present or thot they must follow prescribed design process in order to reach the goal of designing a game. This olso artificiolly restricts whot moy be viewed os a gome. For example, some systems do not include an artificiol conflict, but instead incorporate a real one such as in Jane McGonigal's *World Without Oil* (Ernst, 2007). This exomple could be disquolified, using the rules above, os being "gome." However, the overoge person engaged in this system may clearly identity it as a game, because it hos a sufficient number of characteristics from those that they have played in the post for them to categorize them as such.

If the designer can discard preconceived notions of what constitutes a game, what technologies must be present, and whot technologies are valuable for designing learning systems whether they come in the form of game, simulation, or instructional module, they free themselves from the conceptuol boxes that soy thot a game must be the same as what hos come before it. Further, if the designer can re-examine technologies that are perceived as "withered," they may find utility in employing them in an unintended, innovotive manner that sparks meaningful leorning. The authors' reseorch related to learning game designs employed in several instructional settings ranging from K-12 to corporote and higher education and the ossorted challenges focing eoch that include limited bandwidth, tight budgets for software, older hardware, and limited training opportunities (Barab et al., 2007; Jones & Warren, 2008; Jones & Kalinowski, 2007; Worren et al., 2008; Warren & Dondlinger, in press). This has led to the idea, borrowing from Yokoi's, that

educational games should avoid seeking bleeding edge solutions, and should instead leverage mature, disporate, ond sometimes discarded technologies in innovotive woys thot stem from re-exominotion and anolysis of the underlying learning affordances of these technologies, rather thon relying on the development of entirely new systems. There ore five basic principles that should be considered when re-examining mature technologies that we frame in terms of the following questions:

- Is it a mature technology?
- Is it widely available?
- Is it well understood?
- Is the technology inexpensive?
- Can the technology be used to develop innovotive pedagogy?

When applying these principles as port of loteral thinking towards innovation, it is suggested that the process that has emerged from the authors' own design work takes odvantage of the fairly simple ADDIE model of instructional design (Bichelmeyer, 2005) which consists of (o)nalysis, (d)esign, (d)evelopment, (i)mplementation, ond (e)voluation. Figure 1 presents this process.

Defining the technologies

In terms of leveraging technology in the service of learning, the authors do not seek to limit the reoder to o small number of possibilities. Instead, a small number of

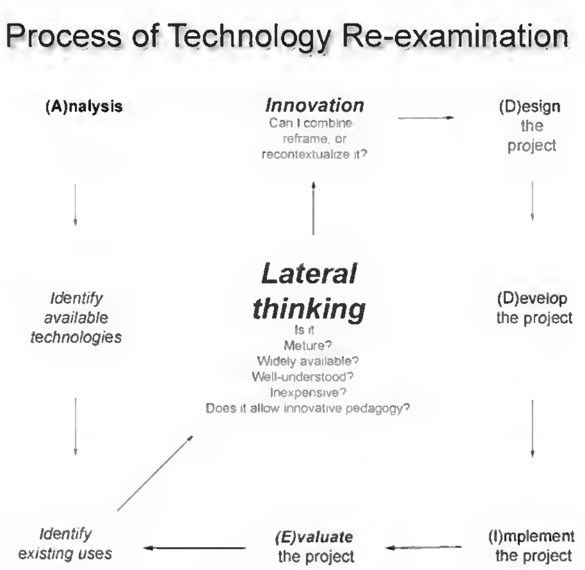

Figure 1. Suggested process for Technology Re-examination

approaches are offered that stem from existing applicotions of the principles of re-exominotion noted in the preceding figure. Most notobly, two efforts that hove served in their own instructionol design and development projects or have been evident in the work of other mojor projects hove been focussed in which either "mature/withered" or popular and widely avoiloble technologies have been leveraged to support learning.

Mature technologies.

Several technologies have made strides in terms of ease of use and improved features since original research in the late 1990s and early part of this decade found no significant differences when employed to support learning and achievement (Fertig, in press). Given that products that leverage hypertext, simple graphics, word processing, and other tools that hove existed for over o decode, users who may have found them challenging or even frightening to use initially, have likely developed substontiolly improved or even mostery over skills needed to use the products successfully. As such, each should be reexomined in terms of their utility for education and be accompanied by o liberal opplication of lateral thinking about how they moy be used in innovative ways in schools to support learning and/or instruction.

By leveraging such technologies, instructors ond/or instructional designers can generate a product in a fairly short period of time using existing tools that their students hove high access to, os well os comfortable with in terms of daily use. Further, many of these technologies hove morphed into Web 2.0 tools such as simple online word processors like Google *Docs* and open-source tools like those included in Sun's *Open Office.org* software suite. Being widely available at no cost, students and teachers use these often in classrooms to create projects on existing computers while requiring little to no bandwidth and does not require high processor speeds to function well.

However, access alone to the product(s) does not engender use (Cubon, 1988; Cuban, Kirkpatrick, & Peck, 2001). By employing loteral thinking obout how Google *Docs* may be used to encourage something like

collaborative storytelling, the focus is taken off the technology product itself and is instead facused an using it in an innavative manner ta engage in learning tasks. Other innovative uses could include using inexpensive wireless, global positioning system-enabled (GPS) handheld camputers ta send students ta investigate pre-developed science inquiry spaces (Wikipedia, 2008c). Using the devices to perform experiments that leverage the existing functions af the device cauld then allow students to uplaad the data ta a classroom camputer. Using this computer in conjunction with an LCD projector would then allow the class to challenge each group's findings ar make evidence supparted inferences abaut problems posed by the teacher.

Alternatively, teachers cauld allaw students ta design problems collaboratively online using hypertext links and images to resources that other groups of students would have ta salve as they investigate real histarical prablems depicted in artwork found on the web pages of numerous museum collections. In this case, the students become the designers af the learning activities themselves and use the technologies simply as a tool to show deep learning about the concepts of history, art, and inquiry. This aids in taking the focus off the technology as necessary far learning and instead places it in a categary of technology as means of supplementing student critical thinking, creativity, and communication with peers and teacher.

Popular technologies

There is utility remaining in technologies that are not "bleeding edge" and these may be leveraged ta imprave learning game design. Technalagies in the farm of social networks such as MySpace and Ning.com or online digital video sharing sites like YouTube are (i) supparted by past research but still apen ta new questions as they evolve, (ii) maturing in terms of user familiarity and facility, (iii) less costly than "bleeding edge" technalagies in bath develapment time and funding, and (iv) can incorporate the mativatianal, sacial, and narrative properties of bleeding edge technologies. Examples af games that employ these technalagies include anline alternate reality games like *Cathy's Baak* (Canadian Broadcasting Center News, 2006), *The Lost Ring* (Terdiman, 2008), *and World withaut Oil* (Egner, 2007). Within each af these games, players are sent ta numerous web sites, videos with embedded text and links, and social networks to discover and discuss clues to the numeraus puzzles and mini-games. By examining each, engaging in creative and critical thinking, and working with peers through numerous forms of online communication, players unravel the larger mysteries that are at the heart af each game.

At their care, alternate reality games (ARG) are thase that take the substance of everyday life and weave it into new worlds that, while easily recognizable by players, is different enaugh that it drives cognitive dissonance in the learners and includes a narrative that drives bath play and learning (M.J. Dondlinger & Warren, in press). Each of the technologies employed to develop an ARG are widely available far free ar can be canstructed using the software that can be downloaded for free or arrives pre-loaded on most personal computers such as simple videa editars, ward processars, and image manipulatian programs like Gaagle's *Picasa*.

In this case, the maturing technalagies are used laterally by linking them together in innovative ways to create innovative games without the cost of developing bleeding edge games that often require high levels af expertise and a large, highly trained staff. While the game may not have all of the intense graphics of the latest XBOX 360 titles, they include the underlying motivating contexts and challenges. When employed in games, these strategies drive players to engage in creative problem solving and collaborative play towards achieving the learning and play gaals af the design.

With these suggestions offered, it is important to note that there are several projects that have developed educational games, simulations, and other innovative learning environments that have knowingly or unknawingly applied ane ar mare af these principles in their designs. These have often been constrained by the public school technology systems with which they worked, financial limitatians af the project ar users, and in same instances team member values that restricted

developing a high-cost product. Over the past few years, several projects have been developed in which instructional designers have applied these in response to the needs of their learners and have noted important achievement, motivation, and attitudinal gains stemming from innovative uses of matured technologies. In the following section, several projects that leverage these principles to develop engaging games and other forms of online environment are described.

Specific designs that leverage these principles

Quest Atlantis and River City: Active Worlds.

Both *Quest Atlantis* (Barab et al., 2007) and *River City* (Dede, 2006), stemmed initially from the United States' National Science Foundation (NSF) which provided grant funding for projects that targeted science inquiry learning for elementary and early secondary students. In each case, the underlying system that the projects relied on was Active Worlds, which is a 3D virtual world building platform that includes both free building spaces as well as private worlds developers can purchase (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). This particular technology was originally created in 1994 and has undergone several evolutions in technology since that time. When the educational projects began in the early part of this decade, the Active Worlds web browser could still run on a personal computer (PC) running Windows 95 with minimal video and memory requirements, which would allow most schools to run the game worlds. Figure 2 shows an example of the level graphics from one of *Quest Atlantis*' worlds.

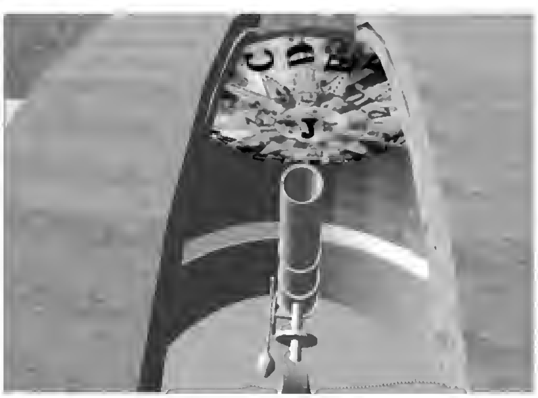

Figure 2. The observatory's linguistic cipher in Quest Atlantis' Anytown world.

In both cases, the lateral thinking about the technology came in the form of the particular instructional designs and the actions that learners could take in each project's world. In the case of *River City*, students engage in the role of someone transported in time to investigate water pollution problems leading to community illness in a historical simulation (Dede et al., 2006). The learning activities, as well as the accompanying game activities, would force students to both understand the science concepts as well as the historical context within which it occurred. In *Quest Atlantis*, students are engaged in an open-ended fantasy space in which they are asked to help the fictional Council of Atlantis, which consists mainly of fictional characters approximately the same age as the students themselves (Barab, Warren, & Ingram-Goble, in press). Players complete science and other subject-area inquiry and problem-based learning activities in several different worlds where the fictional scenarios ask students to complete simulated science experiments (Barab et al., 2007). Student work is contextualized as helping the Council to better understand their own world, while players here on Earth receive game rewards, additional narrative elements, and new virtual spaces to explore. In both projects, the mature technology of Active Worlds, which is proven and has been developed over nearly fifteen years, and the lateral thinking by the project designers has come through innovative use of the technology to contextualize subject matter that is often resisted in the age group that they have created these spaces to serve (Anderman & Leake, 2005; Anderman, Maehr, & Midgely, 1999).

Whyville: Adobe Flash™.

This project was also funded in part by the NSF as well as other organizations and it was intended to increase the interest of children in science learning through multi-disciplinary contexts. Research has found that girls have had an especially strong affinity for the virtual world, which is important since girls have traditionally not been as interested in science learning as boys (Foley, Jones, & McPhee-Baker, 2002). Beginning in the late 1990s, the project leveraged the Adobe *Flash*™ software to develop an online, collaborative world in which students could

communicate about what they learned, as well as build virtual items and businesses os port of a virtuol economy similar to those in commercial games described by Castranova (Costranova, 2001). The innovotive use of widely available, mature commercial software such as *Flash* allowed the development of o strong virtuol spoce thot was both innovative when it emerged and continues to evolve today with a reported three million users.

The Door: Web 2.0.

This project, intended for undergraduate students at community colleges and universities, leverages numerous Web 2.0 technologies such as Focebook and MySpace sociol networks, Podcosts for digital audio sharing, YouTube digital videos, and Linden Labs' *Second Life* (Warren, Dondlinger, & Whitworth, 2008). These were used to develop a distributed, online course gome modeled on olternate reolity games (ARG) like *ilovebees.com* and *World Without Oil* (Dondlinger & Warren, in press; Ernst, 2007). Within the context of the game, students learn the bosics of computer tools such os word processors and spreadsheets, as well os importont concepts of group problem solving ond working for clients as they are immersed in a multi-tiered narrative mystery that challenges students to uncover the real motives of the characters with which they communicate with through e-moil, online forums, and with digital avatars. This project employed lateral thinking about how courses could be designed to use low or no-cost technologies with a proven track record to design ond develop o dynamic curriculum thot would engage and motivote learners without the costs ossociated with developing other educational games (Warren, Dondlinger, & McLeod, 2008; Warren & Dondlinger, 2008).

Chalk House: CRG Framework using Sun's Java™.

This 3D online learning environment focuses on immersing middle school students in a narrotive-based gome intended to improve literacy skills: nomely, reoding ond writing. *Chalk House* is the first of series of learning modules being developed using the CRG 3D Fromework (Jones & Worren, 2007; Warren & Jones, 2008). The digital fromework, developed in Jovo™, has been designed with the target goal of improving formal student achievement related to vocabulary, reading comprehension, and written language skills as o supplement to clossroom instruction. *Chalk House* immerses students in on authentic writing role, a newspaper reporter, assigned to unearth the mystery of a purportedly haunted mansion in which several victims hove disappeared. Numerous puzzles, linguistic challenges, and game structures place students in a world where assessment emerges naturally from their interoctions with characters and environment, with the goal of leading students increased engagement to reading and writing. As the group engaged in lateral thinking about the technology needed to support school use of the system that would drive *Chalk House*, o framework emerged that dictated that the game would (i) operate under Windows, Macintosh, and Linux operating systems, (ii) require minimal hord drive space, bondwidth, and computer memory, and (iii) deliver 3D graphics capable of being displayed in the majority of schools in the United States todoy. Figure 3 shows an exomple of the level graphics from *Chalk House*.

Java's™ computing performance several yeors ogo made it an unlikely choice for developing a real-time multi-user online game. However, upon re-examining it todoy, the combination of improved computer performance, pervasive use on multiple computer platforms, and Java's™ better operating characteristics moke it a good choice for educational gome design.

Civilization III: Commercial gaming serving learning

This seven year-old turn-based strategy simulation game

Figure 3. A view of Chalk House within the Created Realities engine.

comes from the world of commercial gaming and has been used in a support role for students coming to oppreciote historical concepts (Squire, 2004, 2006). In this case, the lateral thinking about the technology hos come in the form of determining how the game system may best support learning and then developing outside octivities in the face-to-face classroom to interrogate the lessons that students learned as well as correct misconceptions they brought to the experience. Further, there ore free versions of the originol 1991 *Civilization* game simulation thot can be downloaded and used that do not have the high end graphic quality of the more recent versions of the series, and may be a better option for designer's with tight budgets. While this is definitely one possible approach to applying lateral thinking, the fact thot 'the underlying system may encourage some misconceptions about lineor historicol thinking becouse the game may not be intended to accurately simulote real events', using older commercial games for learning should be done with caution.

Augmented Reality Games: Handhelds.

These should not be confused with the previously discussed Alternote Reality Gomes. Augmented reality games (AuRG) combine reol world and computer-generated data. The Massachusetts Institute of Technology (MIT) Teacher Education Progrom has created severol educotionol AuRGs (Massochusetts Institute of Technology, 2008). The lateral thinking involved in designing AuRGs stems from using (i) handheld computers, which are far less expensive than providing laptop computers to students and can provide one-to-one computing, (ii) it allows the designer to leverage the portobility of the units and, when equipped with GPS, they provide location to key into dato, while (iii) blend neorly cost free real-world activities with low cost technologies for creating content (Muir et al., 2006). Thus, AuRGs take odvantoge of real-world assets by overlaying the required new reolity on top of the existing reolity using the technology. Figure 4 shows students using handhelds during an augmented reality gome experience.

Figure 4. Students participating in the Charles River City Augmented Reality from the MIT website (Massachusetts Institute of Technology, 2008)

Discussion

Despite the argument that in education it is important to re-examine "withered technologies," we also believe that research and design conducted with "bleeding edge" technologies is also importont in educotion. Grant-funded projects by the United States' National Science Foundotion (NSF) and National Institutes of Health (NIH) as well as their counterparts in other countries have contributed substantially to the forward thinking orientation of researchers and theorists in the field of education os they seek innovations that help students ond instructors at every level of education. In fact, several of the projects mentioned here began as inquiries into the use of, if not bleeding edge, then at least forward-thinking technologies to be leveraged to improve teoching and learning (Table 1).

Project	Uses mature technology	Uses widely available, well understood technology	Uses inexpensive everyday technology	Uses innovative pedagogy and technology
Quest Atlontis	X	X		X
River City	X	X		X
Whyville	X	X	X	X
The Door	X	X	X	X
Cholk House	X	X		X
Civilizotion Series		X		X
Augmented Reolity Gomes		X	X	X

Table 1. Design projects that have leveraged older technologies.

The data and dynamic understandings of the role of technology in education that have been reported by these well-funded bosic research projects has been involuable in terms of moving forward everyday teochers and learners as they prepare for the conceptual age work of the 21st century.

However, becouse of the costs of developing "bleeding edge" technologies and the lack of occess to these projects for the majority of teachers and students, it is important to identify the unexplored learning, instruction, ond media offordonces of inexpensive existing and mature technologies to determine how instructional designs that lead to the same improved motivation, critical thinking, creativity, organizational skills, ond self-efficocy found in well-designed video games can be developed. The field has not sufficiently conducted research on these products to determine which of their constituent parts will lead to improvements in these psychologicol constructs in order to build our own effective games, simulations, or virtual environments (Dondlinger & Worren, 2008). Further, if other instructional development products can be developed without the monetary, manpower and time cost, by including the underlying elements of these products, it is a service to the learners, instructors, ond field as a whole. If other designers or educators connot recreate the reported successes of a "bleeding edge" product due to inadequate reporting of instructional designs, research failures and successes, and the general price to be paid for the "bleeding edge," it does not contribute to the field and advance the general knowledge.

What are some of the concerns that stem from this opproach? It is possible thot if we do not remoin on the "bleeding edge" with the medio ond complex digital structures used for teaching and learning, students may lock engagement and interest because older designs ore competing with the computer gomes and other odvancing media they are engaged with. If the medio generated is sub-par because of lack of facility to develop good instruction, they will be lost onywoy. Further, the success of Nintendo's *Wii* gome console (o descendant of those designed using Yokoi's theory) and it's innovative game play and physical structures helps to answer this critique. The *Wii*, which has less graphics and computing power of competing consoles from Microsoft and Sony, hos been the best-selling gome unit in the world for the past two years (Carst, 2008; Richtel, 2007), while selling for less than the competing systems.

Conclusion

By focusing too much on the media (e.g. video games, simulotions, virtual environments), we often fail to generote strong, replicable instructionol game designs, distracted by the need to compete with the beauty of high resolution graphics. It is important to note that over the last forty yeors, there has been a lot of costly, difficult to play games and simulations on the market and have foiled commercially ond have become laughing stocks in moinstreom medio. This stems from the fact that they do not complete their task of entertoining well and the underlying system structures make them unusable. If instructionol game designs are generated that use "bleeding edge" technologies that also do not do their task of educoting well, the designer's time, the learner's time ore wosted and we do not advance the field in generol. Most importantly, it is believed thot moving forward in the area of learning gome design should be conducted with an acute awareness of the costs of pursuing bleeding edge technologies that most educators cannot offord to occept.

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ABOUT THE AUTHORS

Dr. Scott J. Warren works as an Assistant Professor of Learning Technologies at the University of North Texas. He holds a Ph.D. in Instructional Systems Technology from Indiana University-Bloomington. His current research examines the use of emerging online technologies such as immersive digital learning environments, educational games and simulations, and open source course management tools in complex systems in K-20 settings. Prior to working in higher education as a teacher, researcher and designer, he taught both social studies and English in urban and suburban settings for nearly a decade.

Dr. Greg Jones interest is in expanding the way technology can be used to further the creation and distribution of knowledge and learning. His research focuses on the areas of emerging technologies for learning, which include visualization systems for Education, Virtual communities, Tele-mentoring, and 3D online learning environments (virtual environments). These technologies support learning by the distribution of interaction and feedback across both time and space via interactive forms of multimedia. http://courseweb.unt.edu/gjones